

## MISCELLANEOUS.

*Classification of the Pelecypoda.—Emendatory Note.*

By B. B. WOODWARD, F.G.S. &amp;c.

By an oversight, when rearranging Fischer's families of the Pelecypoda to suit Pelseneer's classification, the Tancrediidæ, which by Fischer are placed between the Unicardiidæ and the Donacidæ, were grouped with the former instead of with the latter. In the table given, therefore, in the February number of the 'Annals,' pp. 158, 159, the Tancrediidæ should stand as Fam. 42 instead of 49, and the Fams. there numbered 42 to 48 should be 43 to 49.

*A Contribution to the Developmental Cycle of the Compound Ascidiæ.* By JOHAN HJORT, of Christiania.

## I.

(1) Like Metschnikoff \* and Della Valle † I have always found that the earliest rudiment of the bud of *Botryllus* is in the shape of a two-layered vesicle, of which the inner layer proceeds from the parietal layer of the peribranchial cavity, while the outer one is derived from the ectoderm of the larva. I have never been able to confirm the repeated assertions of Giard ‡ and Herdman § that in the Botryllidæ a "stolonial" gemmation occurs, in that the buds are produced from the stolons of the mantle. Owing to the very numerous transitional stages it is even possible to explain the usually widely separated buds of colonies of *Botryllus* as having arisen in consequence of a "pallial" gemmation. While, however, Della Valle regards the inner vesicle of the bud-rudiments which is formed in the course of this pallial gemmation as endodermal, I myself feel bound, in accordance with the investigations of Kowalevsky || and Van Beneden and Julin ¶ and studies recently made by Willey \*\*, to consider this vesicle as ectodermal, since, according

\* "Entwicklungsgeschichtliche Beiträge," Mélanges Biologiques tirés du Bull. de l'Acad. de St. Pétersbourg, t. vi.

† "Sur le bourgeonnement des Ascidies composées," Archives Italiennes de Biologie, 1882.

‡ "Recherches sur les Ascidies composées," Archives de Zoologie expérimentale, 1872; also 'Comptes Rendus,' 1891.

§ Report of the 'Challenger' Expedition, vol. xiv.

|| "Weitere Studien über die Entwicklung der einfachen Ascidien," Archiv f. mikr. Anat. 7 Bd., 1871.

¶ "Recherches sur la morphologie des Tuniciers," Archives de Biologie, t. vi., 1886.

\*\* "On the Development of the Hypophysis in the Ascidiæ," Zoologischer Anzeiger, xv. Jahrg. no. 400, pp. 332-334.

to the investigations referred to, the peribranchial vesicle of the larva proceeds from its ectoderm. The entire bud-rudiment of the Botryllidæ consequently consists, as in the case of the Bryozoa, of two epithelial lamellæ of ectodermal origin, with mesodermal cells scattered in between. It follows from this that the gemmation of the Botryllidæ differs in this respect from that of the other Ascidiæ, such as *Perophora*, *Clavelina*, *Amaroucium*, *Didemnum*, and *Distaplia*, since in all these cases, either directly or indirectly (through the epicardium and the stolonial septum), the inner vesicle is formed from the endoderm.

(2) From the inner vesicle are developed the intestinal tract, the peribranchial vesicle, and the nervous system.

The process by which the peribranchial vesicle is formed is ushered in by the upheaval of the ventral wall of the inner vesicle, commencing from in front, into two folds which project into the interior. By this means from the single inner vesicle there is formed a median one, which communicates posteriorly by an opening on each side with two lateral ones, the peribranchial vesicles. Now Della Valle asserts that three separate vesicles arise and that the two lateral ones form by fusion the single peribranchial cavity. I have been unable to confirm the occurrence of this secondary fusion; on the contrary, the peribranchial cavity is formed from the beginning as a saddle-shaped double vesicle, which becomes constricted off dorsally from the median vesicle.

The earliest rudiment of the nervous system takes the shape of a nearly hemispherical evagination, situated at about the centre of the dorsal wall of the median vesicle. This evagination soon grows out into a tube, which is directed anteriorly and ends blindly in front. The closed anterior end of the cæcum fuses afresh with the median vesicle; an aperture is formed here, and we now find upon the dorsal side a tube with both ends opening into the median vesicle. The anterior opening lies not far from the oral aperture, which now arises as a fusion between the ectoderm and the enteron; the posterior opening of the tube communicates with the dorsal portion, which connects the two lateral halves of the saddle-shaped peribranchial vesicle. While the latter, as has been described, becomes constricted off from the intestine, this posterior opening also closes up, and we simply find a dorsal tube communicating in front with the intestine.

(3) At this stage we already observe a thickening of the ventral side of the tube, which increases considerably during the subsequent development. Moreover it becomes more and more constricted off from the dorsal section of the tube, while delicate fibres are differentiated in its interior.

This thickening develops into the permanent ganglion, while the tube, which gradually becomes longer and thinner, persists as the hypophysis.

I would here point out that Kowalevsky \*, in the case of *Didem-*

\* "Ueber die Knospung der Ascidien," Archiv f. mikr. Anatomie.

*nium styliiferum*, *Perophora*\*, and *Amaroucium*, likewise derives the nervous system from the inner vesicle, although in a somewhat different fashion. Consequently both in the forms alluded to and in *Botryllus* the intestinal tract, the peribranchial cavity, and the nervous system proceed from the inner vesicle of the two-layered bud-rudiment.

While, however, in the first-mentioned forms this inner vesicle is endodermal, in *Botryllus* it is, as has been shown, of an ectodermal nature.

As is evident from what has been stated above, these results of mine are diametrically opposed to the conceptions of Seeliger † and Salensky. In the case of the buds of *Clavelina* and *Pyrosoma* ‡ the nervous system is derived by Seeliger from immigrant mesoderm cells, while in the latter form it is stated by Salensky § to arise as a thickening of the "outer vesicle." With the last-mentioned author, however, I am so far in agreement in that I also have found a common origin for the hypophysis and the ganglion.

## II.

The mode of formation of the ganglion in the buds of *Botryllus* led me also to study the development of the same organ in the larvæ of compound Ascidians. It will be seen from what follows that owing to these investigations I have discovered several parallels between the development of buds and larvæ.

In the cerebral vesicle of the larva of *Distaplia magnilarva* there appears at an early stage a difference between the left and right sides. Nearly in the middle of the right side of the cerebral vesicle there arises an evagination, which soon exhibits the most manifold differentiations, and from which in later development proceeds the larval brain, which has been so exhaustively described by Van Beneden and Julin ||.

The left wall, however, in the meantime maintains its indifferent cellular character: at first consisting of a single layer, it gradually increases in thickness.

In front of the described evagination of the right wall of the cerebral vesicle the latter becomes tubular and joined to the intestine. This anterior portion possesses cells of the same constitution as that of those of the left wall.

\* Kowalevsky, "Sur le bourgeonnement du *Perophora Listeri*" (transl. by Giard), Rev. d. Sc. nat., Sept. 1874.

† "Eibildung und Knospung von *Clavelina lepadiformis*," Sitzgsber. d. kais.-kgl. Akad. d. wiss. Wien, 1882.

‡ "Zur Entwicklungsgeschichte der Pyrosomen," Jenaische Zeitschrift, 23 Bd.

§ "Beiträge zur Embryonalentwicklung der Pyrosomen," Zoologische Jahrbücher, 1891.

|| "Le système nerveux central des Ascidies adultes et ses rapports avec celui des larves urodèles," Archives de Biologie, t. v., 1884.

During the development which succeeds this stage the following important changes set in :—

(1) The anterior portion of the cerebral vesicle, which was joined to the intestine, acquires an opening into the latter, and thus forms a communication between intestine and cerebral vesicle which persists throughout the whole of the larval period.

(2) The multilaminar left wall of the cerebral vesicle produces nearly at its middle a thickening, which gradually becomes constricted off, and goes to form the permanent ganglion.

The left wall itself, which hitherto formed an undivided mass in conjunction with the permanent ganglion, after the latter has become constricted off assumes an epithelial character. In front it is directly continuous with the anterior portion of the cerebral vesicle. This portion also becomes epithelial, elongates, and represents the well-known ciliated pit.

(3) Now while the larval brain (formed by the evagination of the right wall of the cerebral vesicle) becomes constricted off and disappears, the epithelium-like left wall of the original cerebral vesicle bends round into a tube, which represents an immediate prolongation of the ciliated pit just described, and in which we recognize the hypophysis.

(1) In the development of the larva, as in that of the bud, we consequently find that the hypophysis and the persisting ganglion have a common origin.

(2) The common rudiment is tubular in both modes of development, and in both cases the ganglion is formed as a thickening of the tube.

(3) The larval cerebral cavity opens, as described by Kowalevsky\* and disputed by Van Beneden and Julin †, through the hypophysis into the intestine.

(4) In the adult animals, produced from the larva, there persists from the lumen of the larval cerebral vesicle only the lumen of the hypophysis.

The above investigations were carried out in the Zoological Institute in Munich and in the Zoological Station at Naples. It is a pleasing duty to express to my revered teacher, Prof. Hertwig, and to Dr. Dohrn my best thanks for all the kindness shown to me. —*Zoologischer Anzeiger*, xv. Jahrg. no. 400 (Sept. 12, 1892), pp. 328–332.

Munich, June 29, 1892.

\* "Weitere Studien über die Entwicklung der einfachen Ascidien," *Archiv f. mikr. Anat.* 7 Bd., 1871.

† *Op. cit.*